Production Of Propionic Acid From Syngas

Team Echo:

Sabah Basrawi

Alex Guerrero

Mrunal Patel

Kevin Thompson

Client Mentor: Shannon Brown

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28. **EXECUTIVE SUMMARY**
    1. Abstract

With an estimated world production of capacity of 377,000 metric tons in 2006, Propionic Acid is an important organic acid that does not receive much publicity. Propionic Acid – which occurs naturally in apples, strawberries, grains, cheese, and human sweat – is mainly used as a mold inhibitor for various animal feed and baked goods as well as a preservative in cheeses. It is also a significant precursor in many industrial processes such as pharmaceuticals, plastics, plasticizers, textile and rubber auxiliaries, dye intermediates, as well as flavorings and cosmetics. Our group has designed a chemical plant for the production of Propionic Acid with a projected output of 33,000 tons per year. The initial feedstock will comprise of Sygnas (a mixture of CO and H­2) and Ethylene, which will react in a process known as carbonylation in the presence of a catalyst to produce Propionaldehyde. The Propionaldehyde will then be oxidized to produce Propionic Acid. The market demand for Propionic Acid is expected to grow at around 2.3% per year regardless of the state of the economy since food production and preservation is highly dependent upon it. With a steadily increasing market price and demand for Propionic Acid along with its marketability in other industrial processes combined with its high price relative to our cheaper reactants and catalysts should make the proposed plant a very economically feasible one.

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   * 1. Commercial Production

Propionic Acid – which occurs naturally in apples, strawberries, grains, cheese, and human sweat – is mainly used as a mold inhibitor for various animal feed and baked goods as well as a preservative in cheeses. It is also a significant precursor in many industrial processes such as pharmaceuticals, plastics, plasticizers, textile and rubber auxiliaries, dye intermediates, as well as flavorings and cosmetics.

* + 1. Environmental Review

- Industrially, the majority of Propionic Acid is used as a bactericide and fungicide to protect hay and grains that are being stored as well as an ingredient for pesticides. As a result, EPA determined it has low toxicity to fish, invertebrates, birds and mammals.

-Nickel Carbonyl: Although Nickel Carbonyl is an industrial standard for the carbonylation of ethylene it is a very dangerous substance. EPA classifies Propionic Acid as group 2B – Probable Human Carcinogen and the OSHA Permissible Exposure Limit (PEL) is 1 part per billion. Sulfur poisons this class, but we are requiring that team Foxtrot remove as much Sulfur as possible.

-Cobalt Catalyst: The only known poison is potassium.

* + 1. Specifications to Meet Industry Standards
    2. Clear Statement of Feedstock
    3. Engineering Design Standards

1. Block Flow Diagram
2. Process Flow Diagram
3. Material and Energy Balances
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5. Annotated Equipment list
6. Economic Evaluation factored from equipment cost

Propionic acid is used in many daily processes such as plastics and food preservatives and without it or an alternative to Propionic acid the quality of life would decrease. Propionic acid was chosen mostly due to its ability to preserve food and have it last longer. The longer shelf life that food has the more affordable it will become as food vendors will not have to throw away as much food, as their expiration times are increased by preservatives.

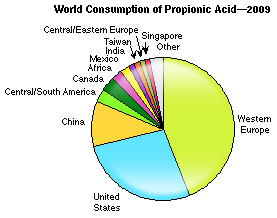


Figure ???: World Demand of Propionic Acid

In the above figure it can be seen that the United States is the second largest user of Propionic acid coming in second to Western Europe. As Western Europe is a region it can be inferred that the United States is the nation with the largest usage of Propionic acid. This information is encouraging to team Echo because it can be reasoned that because the U.S. is using so much Propionic acid that there must be a sizable demand for the product.

Figure ??? Price of Propionic Acid over the past decade

As can be seen in the above figure the price of Propionic acid has been steadily increasing over the past decade approximately doubling. This reinforces the idea that there is a great demand for Propionic acid. After all, with the increasing price and no decrease in the amount of Propionic acid used it can be inferred that it is very important and necessary. This is most likely due to the wide range of uses of Propionic acid. The relevance of establishing that there is a great demand for Propionic acid in this country is to determine the longevity of the project and whether or not it will pay out. The life of this project should be quite long as the demand for Propionic acid is not decreasing and is projected to rise over the next few years. As team Echo intends to target its sales towards food companies and the demand for food is always around without question, team Echo feels that this project will be profitable and long lasting.

|  |  |  |
| --- | --- | --- |
| Component | Price per year | Source |
| Ethylene | $ 14.7 million | Isis |
| Syngas | $5 million | Foxtrot |
| Cooling Water | $ 18,000 | Aspen |
| Catalyst price |  |  |
| Project Capital Cost | $ 62 million | Aspen |
| Estimated Operating Cost | $11 million | Aspen |
|  |  |  |
|  |  |  |

Table ???: List of Costing Material

If all 33,000 tons of Propionic acid is sold each year then the process will gross approximately $ 29 million per year. This yearly gross price in conjunction with all of the costs that will be incurred are used to establish a breakeven point. The sooner the breakeven point occurs the sooner that the process will start making money.

1. Utilities
2. Conceptual control Scheme

The plant will require around ten workers. Each of these workers will be paid a base pay of $12/hr. Workers will have a maximum of 4 weeks of vacation time which does not roll over, thus if not used it will be lost. Workers will start will 1 week of vacation every year they will be evaluated as to whether or not they are permitted more paid vacation time.

In addition to these 4 weeks of vacation 5 sick days per year will also be given though In order to ensure that the plant is fully staffed at all times there will be four differing shifts that have been arranged so that there should be no overlap, and also so that there will always backup workers in case an absence should occur.

As leadership is always necessary one individual form each shift will be selected in order to become a shift manager. The shift manager will be required to select an approved backup manager. The shift manager and back up will be paid $18/hr and $15/hr respectively. The shift manager and the backup cannot be absent at the same time.

Benefits will include basic health care through United health care. This is strictly medical and there is no copay as the beneficiary and their dependents will have a maximum of $3000/yr to spend on health care per year. An advantage 90 Drug Program comes with this plan which will allow the employees to obtain any prescribed generic drugs for free from all participating Walgreens. Dental insurance will also be supplied through unicare

1. General Arrangement (Plant Layout)
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8. Location Sensitivity Analysis

The plants producing Propionic acid and syngas will be based in Morris, Il 60450. Team foxtrot based themselves in southern Illinois so as to be near Illinois coal basin number 6. As the syngas that team Foxtrot is producing is quite difficult and expensive to transport, in order to lower costs for both teams it has been decided that team Foxtrot and team Echo will be located next to each other. The determinant factor of team Echo’s location is Ethylene. Ethylene like syngas is quite expensive and difficult to transport. The region near southern Il was scoured to find ethylene production plants, and while the search lead heavily towards Texas and Louisiana eventually Lyondell Basell in Morris, Il was found and settled upon. In Morris, both teams have chosen to be located as close to a rail line as possible in order to minimize the coal transportation costs of team Foxtrot as team Foxtrot will currently be approximately 5 hours away from southern Il.

Morris, Il is a small town that is very historical yet not unwilling for progress. Not only is Morris home to Lyondell Basell and soon to be teams Echo and Foxtrot but it is also home to Dresden nuclear power plant which is one of many plants that supplies power to the Chicago land area. Bill Cheshareck is in charge of all building and zoning permits and is who must be contacted in order to determine what needs to be done in order for plants to be built in Morris.

1. ESH Law Compliance
2. Laws of Physics Compliance
3. Turndown Ratio

In order to have enough time to properly ensure that all machinery is in proper working order and to ensure that any problems can be fixed it is integral a proper turn down ratio is selected. Usual turn down ratios are around 30 days, and team echo will be going with a turn down ration of 28 days, thus the operating year will be 337 days. Team foxtrot will be operating at an 18 day turn-down ratio and thus their syngas will be stored during the 10 days in which the echo plant will not be operational.

1. Applicable Standards
2. Project Communications
3. Information Sources and References